Transverse Energy and Energy Density Production at RHIC*

Q. Li

It is highly expected that the new form of matter - Quark Gluon Plasma (QGP) - will be created in collisions at RHIC. One of important parameters for the creation of QGP is the initial energy density (ϵ). Lattice QCD calculations give us the critical energy density (ϵ_c) for the transition to quark-gluon plasma in the range $1 - 2GeV/fm^3$. The questions are, however, (i) whether the required energy density can be reached? (ii) for how long and over how large volume the ϵ of the system is greater than ϵ_c?

In this report, we show a study of the energy density and transverse energy (E_t) as a function of collision time. Energy-momentum tensor is computed for extracting ϵ. The energy-momentum tensor is defined,

$$T^{\mu\nu}(\vec{x},t) \equiv \sum_i \int d^3p \frac{p^\mu p^\nu}{p^0} f_i(\vec{x},\vec{p},t) \ . \qquad (1)$$

From $T^{\mu\nu}$, the pressure, energy density, and flow velocity can be extracted. The results of E_t and ϵ as a function of collision time (τ) are shown in Fig.1 (a) and (b), respectively. A total of 144 central RQMD (b = 0fm) (v2.4) Au+Au events ($\sqrt{s} = 200GeV$) are used to compute $T^{\mu\nu}$.

There are, in general, two stages in the evolution of E_t. Initially, E_t increases due to the transverse excitations from interactions. Afterwards, the longitudinal expansion results in a decreasing E_t. What we measure in the experiment is the final E_t at the end of this expansion. The details of the E_t evolution, like all other observables in the relativistic heavy ion collisions, is model dependent.

In the RQMD events, during the early stage, the longitudinal pressure is higher than the transverse pressure. After about 7 fm/c, the system is approximately isotropic, but it is still not in a local thermal equilibrium.

Footnotes and References

*Collaboration with Y. Pang and N. Xu

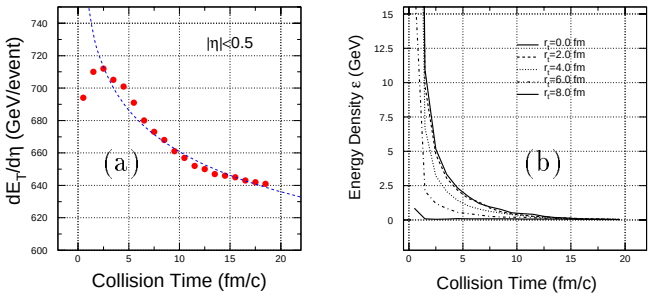

Figure 1: *(a) Transverse energy at mid-rapidity as a function of time for central (b = 0fm) Au+Au collisions at RHIC from RQMD v2.4; (b) Local energy density, as a function of time at various positions ($z = 0$ and $r_t = 0, 2, 4, 6, 8fm$) for the same set of collisions.*

Clearly, the system in Figure 1, can not be described by a simple Bjorken expansion picture. There are expansions along both the longitudinal and the transverse directions, and the system is not in a local thermal equilibrium. The time evolution of ϵ and E_t, are not exactly correlated. So the measurement of E_t by itself is not sufficient to determine ϵ[1]

The dashed line in Fig.1(a) is $E_t = E_t^0 \tau^{-\alpha}, \alpha = 0.055$. Note that in idea case, $\alpha = 4/3$. More studies on the correlation between logitudinal and transverse expansion are called for in order to understand the α parameter.

The initial state in RQMD is not partonic, so it may not be applicable for RHIC. But the model may still have a reasonable parametrisation for stopping and for initial transverse energy production.

Footnotes and References

[1] Q. Li, Y. Pang, and N. Xu, Proceedings of *Heavy Ion Physics From Bevalac To RHIC*, p126, Ed. Seto, World Scientific 1999.